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ABSTRACT

This report begins with a discussion of the present position of girls and women in science and technology, commenting on several kinds of problems to which interventions to encourage schoolgirls into science and technology may be addressed; these problems relate to enrollment, interest, and career intentions. The major portion of the report is divided into eight sections which correspond to the primary types of intervention which have been adopted in several European countries. The first section deals with broad-based interventions aimed at increasing equality of opportunity. Subsequent sections deal with interventions related to: curriculum choice options; girls' attitudes toward future careers, science interests, and the perceived difficulty of physics; strategies used to combat the sex-typing of craft subjects; work experience schemes, especially those organized from the school (in view of the powerful impact of career expectations on girls' subject choice) in the Netherlands, Sweden, and the United Kingdom; classroom behavior, including teacher attitudes toward girls in science and technology; interventions to improve post-school entry of girls into science and technology; and several others which do not fit into the previous categories. Based on these intervention strategies, kinds of measures which may be used to reduce the underachievement of girls in science and technology are offered and discussed. (JN)

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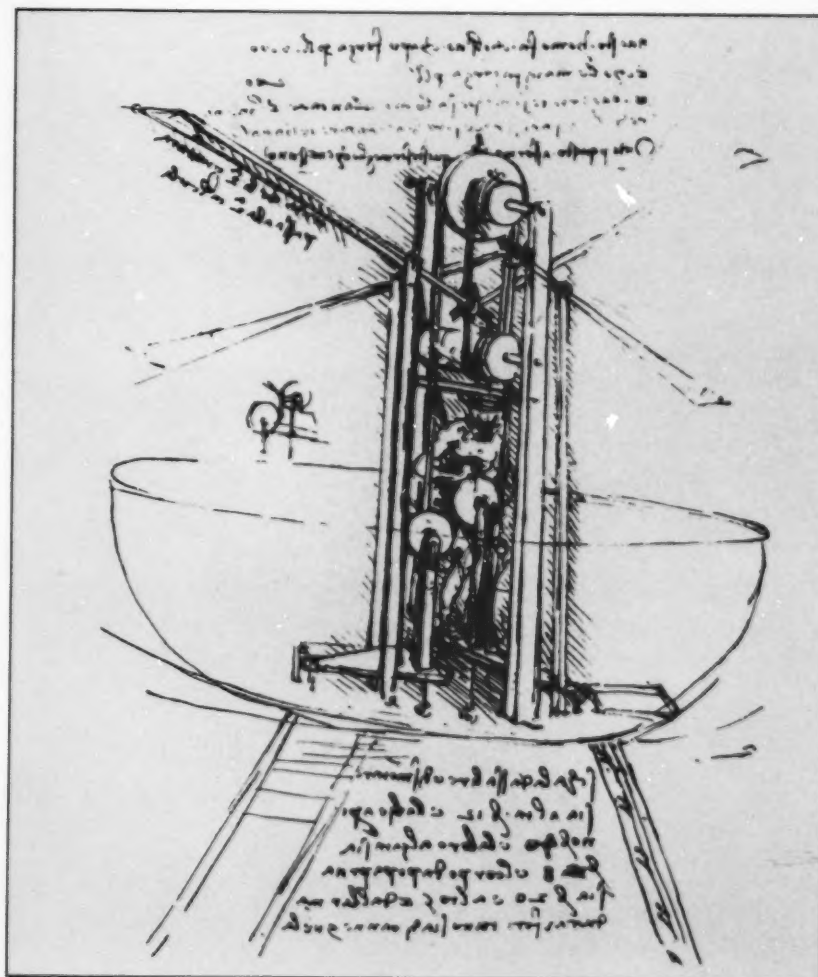
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Encouraging Girls into Science and Technology : Some European Initiatives



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SCIENCE AND TECHNOLOGY EDUCATION DOCUMENT SERIES

Number 7

ENCOURAGING GIRLS INTO SCIENCE AND TECHNOLOGY:
SOME EUROPEAN INITIATIVES

by: Judith WHYTE

Division of Science, Technical
and Vocational Education

Section of Equality of Educa-
tional Opportunity for Girls
and Women

Division of Equality of Educa-
tional Opportunity and Special
Programmes

United Nations Educational, Scientific
and Cultural Organization

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P R E F A C E

The access of girls to scientific and technical education is one of the priority areas in the Section of Equal Educational Opportunity for Girls and Women. In an effort to encourage national and international efforts in this field various activities were organized to identify obstacles that impede access and recommend measures for removing them.

This study forms a part of a project on 'Access of Women to Science Education Training and Associated Careers' consisting of research and follow-up activities based on the recommendations of the research: France, Czechoslovakia, Malaysia, Venezuela and Senegal took part in this project. The present study was contracted to the Manchester Polytechnic and undertaken by Judith Whyte, co-Director of Girls into Science and Technology (GIST).

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INTRODUCTION

Although she was to know neither the awful nor the wondrous power of the atom, it is a curious fact of scientific history that it was a woman who first noticed, and then studied, the consequences of atomic disintegration. Marie Curie was exceptional in her talents and in her career. Most women are conditioned to believe that science is no concern of theirs, or, if it is, that they, as women, must be odd, unfeminine and likely to be among the less attractive members of their sex.

Yet this self-and-other-suggested sexual discrimination cannot continue. The inexorable march of scientific and technological progress draws in its wake the need for more and more workers with scientific and technological know-how. If, in the past, this need has been met predominantly by the male sex, the future need will require increasing numbers of female scientists and technologists. Nor is there any biological reason for the sexual imbalance which now exists in these vital fields of human endeavour. Indeed, there is every reason to suppose that an increasing input by female workers into science and technology will be as enriching as was the Curies' joint contribution to science. So, the conditioning - the legacy of tradition must change. The polarity of present attitudes must be revised. And this change must begin where the present process of poisoning starts - in the school.

The need for action at the school level is now widely recognised, and many initiatives are being taken. This document describes some initiatives now being taken in various European countries. During the last four years, knowledge of these initiatives has been shared in a series of conferences, first in Honefoss, in 1981, then in Eindhoven, the Netherlands, also in 1981, thirdly in Oslo, Norway, in 1983, and, most recently, in Kiel, the Federal Republic of Germany, in 1984. The many contributions to these four conferences are the substance of this document.

But the author has done more than merely assemble a selection of summaries. She has discerned seven broad areas for action. These she has called 'general', 'curriculum options', 'science', 'crafts/technology', 'work experience', 'teachers and classrooms' and the 'entry of girls and women to careers in science and technology.' And, under these broad areas, she has analysed the initiatives being taken in various countries. This analysis has enabled her to reach a number of conclusions about what has to be done, and in what order, if school-girls (and schoolboys) are to find pleasure and interest in their science and technology education. For this discovery of interest and pleasure is the essential pre-requisite to a decision to make science and technology the chosen fields for future careers.

This document is timely. It is full of interest and will be found invaluable as a starter for those individuals, institutions, or systems who decide to initiate action or to develop existing initiatives which are designed to rectify the sexual imbalance which now exists among those who study and who work in science and technology.

The author, Ms. Judith Whyte of Manchester Polytechnic is co-director of the Girls into Science and Technology (GIST) project. The opinions expressed are those of Ms. Whyte; they do not necessarily reflect the views of Unesco.

GIRLS AND WOMEN IN SCIENCE AND TECHNOLOGY : THE PRESENT POSITION

In all the countries for which information was available in the preparation of this report, the phenomenon of girls' under-representation and under achievement in science and technology is a notable feature of each educational system. Gardner (1984) has summarized the findings of research reports in 20 countries, including seven in Western Europe. The seven were:

Finland	1
Belgium	4
Scotland	4
Netherlands	5
England	7
Norway	11
Sweden	16

In this list, the figures which follow each country are the number of research reports which refer to gender differences in science, so the balance of reports between countries gives a rough indication of the extent of current interest in the topic, with Scandinavia and the United Kingdom showing the greatest concern.

In all countries, enrolments in science and technology are greater for males, with the ratio of males to females increasing at increasing levels. Gardner's report shows that, in the countries for which he collected information, enrolments in physical sciences were also greater for males, confirming a pattern established by other international reviews (e.g. Comber and Keeves, 1983). There were also more males in computing, engineering and in applied biology courses, the latter in Belgium.

There are also prevalent differences in science interest. At all levels of schooling, males are more interested in science, and are more likely to aspire to a science-based career. The two factors are probably to some extent interdependent. Girls are less interested in science, and do not envisage a career for themselves as a scientist or engineer. Males are likely to be more interested in physics and technology, in understanding how things work, in learning practical skills, and in studying science with a career in mind. Females are more likely to be interested in biology (particularly human biology), in social science topics, in the social implications of science, and in learning science for its intrinsic interest rather than for career purposes. Females tend to perceive science as more difficult, and they are less likely to feel confident about their ability to study science. (Gardner 1984)

According to Gardner, a few studies have explored some of the social forces which help to shape such differences. Males are more likely to hold negative stereotypes about females who study science. If so, females who do decide to study science must be prepared to face male disapproval. Again, females are less likely to receive favourable advice about enrolling for science subjects. And some English studies suggest that, despite the supposed advantages of co-education, mixed schools tend to encourage the separation of males and females into physical and biological sciences. However, this is still an issue of dispute, and it has been claimed that much of the supposed advantage to girls of single sex schooling is really an advantage of social class, as many, if not most English single-sex schools are selective and independent of the

state sector, with a disproportionately large representation of middle class girls.

There are, therefore, several kinds of problems to which interventions to encourage schoolgirls into science and technology may be addressed. Some relate to enrolment, some to interest and some to career intentions.

Enrolment of girls on courses

In order to increase the number of girls enrolled in science and technology courses, accurate information needs to be collected about the distribution of males and females at each level. Such statistics are usually collected by schools. But, as one researcher discovered (see p.6 below), data may be combined at regional administrative level, making it difficult or impossible to monitor progress.

Subject option systems may be reviewed to discover whether inbuilt mechanisms or unintended bias informally excludes girls from enrolling; for example, setting 'boys' subject against 'girls' subjects in the time-table encourages children to make choices in line with sex role expectations.

One possible intervention strategy is to take positive action, or establish a quota system to allow more girls to enrol on courses in science and technology. But the latter seems only to have been used in relation to tertiary education.

Sex differential interests

There is considerable evidence that, even from quite an early age, girls and boys have different interests in different aspects of science and technology, and that, in general, courses tend to be geared overwhelmingly to male interests. Curricular reviews may be necessary to promote the introduction of topics and approaches which are interesting to girls. For example, instead of taking the structure of things and how they work (a male interest) as a starting point, science/technology courses could be taught within a framework which involves consideration of the social implications and the everyday applications of science and technology. Such an approach would seem likely to increase girls' interest and enjoyment of science subjects. And, as it appears that both sexes are interested in the impact of science and technology on social and human affairs, boys will also benefit. (see p. 13 below).

Career intentions

There appears to be a close relationship between interest in science and the careers children envisage for themselves. As the fields of engineering and technology are almost exclusively male, and science is male-dominated, positive action is needed in order to prepare the way for girls to enter occupations which are non-traditional for their sex. This can mean making special provision and establishing support systems alongside equality of provision, especially in the first work or training placement. It also calls for the adaptation of courses at tertiary level.

Careers counselling, and advice which is school-based, frequently appears to be highly traditional, directing and channelling girls and boys into predictable routes. A policy of positive support and encouragement for children to make non-stereotyped choices is likely to be necessary before girls will take the risk of entering traditionally male careers.

Interventions

The main part of this paper is divided into seven sections. These correspond to the primary types of intervention which have been adopted in several European countries.

The first section A, deals with broad-based interventions aimed at increasing equality of opportunity. They are therefore not necessarily focussing on girls and science and technology. In some countries, this seems to have been the only kind of initiative which has taken place, but it is probably important as a preliminary to the recognition of the problem of girls' under-attainment in scientific and technical subjects.

Curriculum options at secondary school level are the chief mechanism whereby girls are channelled out of science and technology. And, because of pre-emptive options, few girls are eligible to enter apprenticeships in traditional male trades or to go on to courses in science and technology at tertiary level. Section B gives an account of the Dutch 'Free Choices' project, and various similar, initiatives, mainly in the UK and in Scandinavia, where option choice systems have been reviewed in order to increase the chances of girls electing to stay on school courses related to scientific and technical careers.

In all countries, the school subject viewed with least favour by children is physics, and girls are more severely under-represented in physics than in any other science subject. The major reasons for girls' avoiding physics relate to their different interests in science and technology, the perceived difficulty of physics, and their perception of their own future careers (Kelly et al., 1984). In Section, C, several initiatives are mentioned which have addressed one or more of these problems.

Technical crafts, or technology is taught in a variety of ways in different countries, but everywhere there is a tendency to categorize these subjects as masculine, and to divert girls onto courses of traditional feminine interest, such as home economics, fashion or cookery. Strategies which have been used to combat the sex-typing of craft subjects are reported in Section D.

In view of the powerful impact of career expectations on girls' subject choice, work experience schemes organized from the school offer one possible measure for broadening opportunities. Section E reports such initiatives in the Netherlands, in Sweden and in the United Kingdom.

The attitudes of teachers to girls in science and technology can be crucial in determining whether they will elect to continue their studies in these areas. Observation of classroom interaction indicates that boys assert their dominance in the lab and the workshop by making disproportionate use of available resources and by demanding more teacher time and attention.

Teachers who are unaware of this subtle process of informally excluding girls can inadvertently discourage female pupils even further when they exhibit prejudiced or stereotyped expectations. Section F reviews some relevant work in this area.

The qualifications required for entry to courses in tertiary education can affect the recruitment of girls to science and technology. In some countries, girls have the relevant qualifications, but choose not to take the courses; in others they are simply not qualified to enter the scientific or technical field. Initiatives in several countries which have tried to increase the recruitment of girl students are described in Section G.

A. GENERAL

It appears that studies of textbooks and children's reading books for sex bias are the most preliminary and basic feature of programmes to counter girls' disadvantage, and represent the first stage of such initiatives.

For example, research in France has concentrated on the images of men and women which children's reading books and textbooks presents. Andre Michel (1982) reports on several analyses of the portrayal of the sexes in books used in French schools in a study made by Suzanne Mollow in 1970. The most important French initiative on sexism and schools was begun by women journalists in 1976, leading them to set up an association called 'Pour Une Ecole Non-Sexiste'. The main achievements of this organisation were recommendations to authors of school books sent out by the two largest French school publishers, the growing awareness of primary school teachers, and the bills tabled in parliament. It is only very recently, in 1984, that Catherine Valabregue, one of the founders of 'Pour Une Ecole Non-Sexiste' has drafted a French proposal rather similar to the British GIST (Girls Into Science and Technology) project, with similar aims.

The sources of initiatives in each country tend to be of the following kinds: independent researchers (sometimes women); independent women's organisations; bodies with statutory responsibility for equal opportunities, such as Equality Commissions; other governmental agencies, e.g. the Ministry for Women's Affairs, or the Ministry of Education, Culture etc. In some countries, initiatives have led to national planning, starting with the country's capital.

For example, in Portugal, in 1978, Unesco supported a study in secondary schools and teacher training colleges on the factors which determine girls' and boys' educational and vocational choices. Subsequently, the Portuguese 'Changing Attitudes' project - essentially a general awareness-raising campaign - was started in cooperation with the Ministry of Education. It involved national meetings, work with teachers, the production of written and audio-visual material and attitude surveys. (Romao, 1981). Its main features were four in number:

First, cooperation with the Ministry of Education. This included national meetings held in Lisbon in support of which the Basic Education Unit funded teachers' and headteachers' travel, board and lodging.

Second, was the production of a book for use in primary schools to stimulate discussion. Using the slogan 'Girls and Boys, Same World, Same Tasks', the book was circulated to all schools and training colleges in 1982. Also, a project symbol was produced, and used on posters, stickers and plastic bags. Two films were made for awareness campaigns in teacher training colleges, and slides and photographs were also produced.

Third, teachers systematically tested activities oriented towards changing pupils' attitudes to sex role. Pilot activity was first carried out in Lisbon, then taken to other parts of the country.

There was a good media response, and a forum was held for writers, designers, publishers, headmasters, journalists, broadcasters, infant teachers and teachers of the mother tongue and of literature.

In Ireland, the source of change was a report from ESRI, the Economic and Social Research Institute on Schooling and Sex Roles, (Hannan, 1983). On publication of the report, the Employment Equality Agency produced a summary and recommendations. These have now been taken up by the Department of Education.

The ESRI report confirmed that there were considerable variations between schools in their subject provision and in their allocation practices. One of its main recommendations is the establishment of a Curriculum Review body. Measures designed to bring about change should focus on: aids to the management of schools, the recruitment of teachers as a means of enlarging curriculum options and flexible timetabling. Agencies of change should be teachers, guidance counsellors, parents and the local community, assisted by such outside agencies as the Department of Labour, AnCo (the Industrial Training Authority), and the Youth Employment Agency.

The Department of Education has a general commitment to 'eliminate sexism in education' by means of a publicity campaign. In primary education, a review of formal and hidden curricula is planned, with the revision of mother tongue texts, and discussion with and guidelines for publishers. In post-primary schools, the following measures are proposed:

- the proposed National Curriculum and Examinations Board should seek to eliminate sexism from curriculum and exams;
- the monitoring and evaluation of curricula by Inspectors;
- staffing and resources to coordinate, direct and cooperate;
- the composition of syllabus committees should be broadened;
- junior and science core curricula should be reviewed;
- Group and Intermediate (school leaving) Certificates should be merged;
- schools should be encouraged to share resources for options;
- schools should have equal access to pre-employment types of courses;
- candidates who have failed higher maths should be considered for a pass grade;
- mixed schools should be encouraged to offer technical subjects to both boys and girls;
- a feasibility study should be made of integrated technology at junior level;
- a feasibility study should be made of a module in 'living skills'.

In teacher education, there will be a review of pre-service provision, substantial provision for inservice education a review of the conditions of appointment of principals, an amalgamation of schools' policy to provide opportunities for girls to study scientific and technical subjects, and an educational resource centre to be set up within the Department is proposed.

In relation to pupil guidance and counselling, the role of guidance counsellors will be reviewed, guidance and counselling will be integrated into all aspects of school life, and guidance programmes for girls will include a variety of approaches.

The financial implications are between six and seven million Irish pounds, the largest items being for scientific equipment (£ 2m), pilot projects (£ 1.5m) and a reprint of teachers' handbooks (£ 1m).

B. CURRICULUM OPTIONS

In several countries, the problem of girls' underachievement in science and technology has been identified as stemming from systems of options which channel girls away from subjects traditionally considered to be 'masculine'. This is reflected in statistics of examination candidates and in the proportion of girls who enter schools with a bias towards science. Table 1 illustrates.

Percentage of Girls in Science and Related Courses in
Upper Secondary Schooling in Seven Countries

<u>Country</u>	<u>Percentage of Schoolgirls</u>	<u>Year</u>	<u>Details</u>	<u>Source</u>
<u>Group I</u>				
Netherlands	27.0	<u>1980</u>	Taking physics courses in VWO (Pre-university educational stream)	Drukker, 1983
U.K.	27.1	<u>1979</u>	Taking A levels in Maths and Science	OECD
<u>Group II</u>				
France	39.5	<u>1981</u>	Maths/Physical Science Baccalaureat	OECD
Norway	41.4	<u>1980</u>	Artium candidates (Science)	OECD
Sweden	45.8	<u>1980</u>	Students on Sciences line in upper secondary schools	OECD
<u>Group III</u>				
Italy	45.3	<u>1977-8</u>	Students in 2nd cycle secondary schools of the scientific type	OECD
Hungary	(50%+)	<u>1982</u>	Girls over-represented in grammar schools, in which maths and physical science compulsory to 18.	Whyte, 1983

Differences between countries in the number of females taking science and technology are partly explained by comparative differences in the age at which subject options are made. It appears that the younger the age when adolescents are offered a choice of subjects, the more likely it is that girls' chances of doing science will be reduced.

Brock-Utne (1981) reports research on curriculum options in the upper Norwegian and Swedish compulsory schools age range 13 to 16. Introduction of work experience, and more options may well prove to be of great consequence to later curricular and occupational choices. Brock-Utne found that, since 1973-4, statistics on curriculum choices have not been divided according to sex. Although they were divided at school level, when local school administrations compile their statistics, they add the numbers of boys and girls together. This highlights the importance of collecting statistics by sex, and monitoring progress in change.

In Sweden, a new curriculum was introduced in 1980-81. In their last three years at school, girls and boys had chosen between knitting and sewing or woodwork and metalwork. The result was that 93% of boys and 20% of girls opted for wood and metalwork, while 7% of boys and 80% of girls opted for sewing and knitting. The new Curriculum Handbook of 1980 limited the number of optional lessons. The Handbook states that home economics, technology and art appreciation should no longer be optional. A telling passage reads: 'the existence and expansion of curriculum options within our compulsory school system destroys the schools' possibilities of "actively counteracting" traditional vocational choices'.

In Norway, the practice of segregating crafts by sex was abolished in 1959. Home economics became a compulsory subject for both boys and girls in the seventh grade. However, it remained optional in the eighth and ninth grades.

The Free Choices project, (see the list of projects which follows the list of references) concerned with curriculum options, was set up in Holland in response to a recommendation from the Emancipation Commission. It has now made recommendations to the Minister of Education. The Advisory Group consisted of representatives from primary and secondary education, the inspectorate, the school advisory service, educational research organisations and an emancipation specialist, who had been involved in the 'Marie Word Wijzer' (Wake Up Mary) campaign. It focused on primary education, and on the lower cycle of secondary education. A policy on priorities has now been implemented in 14 schools, on the initiative of the Minister of Education and Science.

75 percent of girls going to junior vocational schools opt for the domestic science course, and more than 75 percent of the boys opt for the technical course. A small, but increasing number of girls and boys are opting for the non-traditional course for their sex, but the drop-out rate appears to be extremely high. In 1975, it was between 60 percent and 80 percent, while the figure for other junior vocational pupils was 30 percent.

Intervention projects for girls were started in five boys' elementary apprenticeship courses in 1980 to 1981 (i.e. in post-junior vocational schools). All the girls were found to require additional tuition in the main subjects.

they lacked certain basic practical skills, and many of them were deficient in such key subjects as maths and physics. They needed a great deal of assistance, especially at first. Subsequently, it was difficult to find work placements for them, and discouraging work experiences caused some girls to drop out.

In the general secondary schools, girls tend to choose combinations of subjects which offer minimal opportunities for further study. They take examinations at a less demanding level, while boys opt for examinations at the highest possible level.

Existing courses of training did not appear to keep teachers fully informed of the problem of sex inequality in education. As the Advisory Group said: 'Endeavours to mobilize schools in the battle against sexual inequality in education have been disappointing to date... central government's repeated initiatives have failed to produce innovation on any significant scale. The ambivalent attitude of teachers to slogans such as 'breaking the stereotype' and 'equal opportunities' will certainly play a role'.

A major recommendation from the Group is that subject, course and examination options ought to be abandoned. Their further recommendation appear under the following headings:

- avoidance of sex role stereotyping;
- improving and equalising educational opportunities;
- improving counselling; and
- promoting awareness.

The Group's more detailed recommendations are summarized below.

Avoidance of sex role stereotyping

Teaching materials and syllabi should be reviewed, and recommendations made to publishers. Non-traditional materials should be produced, filling gaps on the role of women. New materials should be tried out, and examinations should include questions on the role of women.

A study and discussion of interaction processes should be made, by examining, for example videos of classroom interaction; sex grouping should be discouraged.

The posts and duties of male and female teachers should be reviewed, in view of their likely impact on children, and measures should be taken to appoint more women in management posts in school. Women should be given temporary priority in management posts, and in the teaching of science and technology. And women working in science and technology should be invited into schools.

Improving and equalising educational opportunities.

Technical, three-dimensional and mathematics skills should be developed at primary level, and teaching materials in these subjects should be designed to appeal equally to girls. More subjects should be made compulsory, e.g. general technical studies, and it should be impossible to choose weak subject

combinations. No options should be offered which implicitly encourage sex inequality, and the choice of standard of examinations should be abolished. Postponement of choice is recommended along with the introduction of a common comprehensive first cycle of secondary education.

Vocational education in the upper years of secondary school should be reorganised so as to give free access to a range of vocational courses.

Improving counselling

Changes are recommended to the guidelines for the admission of girls from junior domestic science courses to primary apprenticeship training courses. And measures should be taken to ensure that traditional boys' courses are genuinely available to girls. A national group should be set up to prepare suitable materials, and there should be an increase in the number of traineeships and places for girls on senior vocational courses.

Promoting awareness

Awareness should be promoted amongst pupils, teachers, parents and guardians. The Group remarks: "the idea of 'contesting sex roles' prompts ambivalent feelings amongst teachers. It would perhaps be better to talk of 'refraining from endorsing traditional sex roles'".

According to the report of the Free Choices project, there surveys into role stereotyping in education show that to reject sex role stereotyping is just as effective as breaking down traditional roles.

There is need to promote relevant research and the evaluation of innovation.

Broader measures for a 'general support and encouragement' policy are also put forward: the policy on teaching standards should come from the government, but schools ought to decide how the policy will be implemented. Educational advisory bodies should include representatives from the equal rights field, and preference should be given to women, provided they are equally competent with male candidates. Equal opportunities cannot just be integrated with other policies for disadvantage, as girls' disadvantage has different causes.

In Sweden, a new combined natural sciences and technical course, introduced into some upper secondary schools, has succeeded in attracting a higher proportion of girls, namely from 27 percent to 30 percent. Another form of encouragement at the upper school level has been the awarding of extra points to pupils who apply for a programme in which the representation of their own sex is less than 30 percent (Granstam, 1983).

A Norwegian study of senior high school students, and of their preferences of A level subjects (linjefag) and electives (valgfaag) concludes that the introduction of new option systems is counterproductive to equality objectives in education (Skog, 1983).

In Denmark, gymnasium pupils must choose either the 'linguistic' or the 'mathematical' side. Certainly, girls are over represented on the former, and few choose maths combined with physical science, but there have been pronounced changes in the sex composition on the mathematical side overall, from 25 percent in 1964 to 44 percent in 1982 (Beyer and Vedelsby, 1983). Danish researchers carried out interviews with pupils about the reasons for their choices, and found distinct sex differences in interest: both sexes saw physics and technology as in the 'boys' domain'. The research team intend to continue by making observations of girls' behaviour in different working situations, further interviews with pupils, and experiments with the methods and teaching of physics. (Beyer and Vedelsby, 1983).

C. SCIENCE

The GIST (Girls into science and Technology) project in UK also found distinct sex differences in science interest when children were aged 11 and before they had received any formal science education. Boys displayed more interest in physics topics, and girls in biology. However, both sexes were very interested in human biology. GIST worked with teachers to devise means of teaching physical science in a way which would build more firmly on the interests of both sexes. Simultaneously, work was carried out with children on sex stereotypes, and they met women visitors working in science and technology, and men and women doing non-traditional jobs. Children's attitudes to science and to sex roles changed significantly, in relation to a control group, but the effect on option choices was slight. The three most important reasons given by children for their choice of subjects were first, usefulness for getting a job, second, interest in the subject, and third, own performance in the subject. Interest is probably strongly related to the other two factors. Girls' knowledge that science and technology is a largely male area discourages them from considering relevant jobs. Girls' also tend to under-estimate their own performance, while boys over-estimate theirs. Liking physical science was found to be correlated with perceptions of their own performance for girls, but not for boys. The schools which were most successful in altering options appeared to be those in which teachers had most explicitly spoken to pupils about their concern for girls' under-achievement in science and technology.

Between countries there are wide differences in the degree of concern about the under-representation of girls in science. This may reflect differences between countries in the need for scientists and the relative take-up by girls of science and technology. For example, in Switzerland, the education system is the responsibility of the cantons not of the Confederation. Even in 1971, girls spent one-tenth less time than boys on mathematics and natural sciences, whereas boys spent less time on languages. Girl's extra hours were filled by music and 'women's handicrafts'. There is no available evidence of remedial action being taken in Switzerland. In contrast, in Holland, in Scandinavia and in the United Kingdom there are several projects concerned exclusively with the issue of girls and physical science. Biology is generally regarded as less of a problem, because it is more likely to be chosen by girls, at least at school level.

In most countries, children become disillusioned with physical science in the first three years of secondary school. (Gardner, 1984). Both sexes are curious to know more about science when they start secondary school (Kelly, Smail and Whyte, 1981), but, by the end of third year, boys as well as girls find physics, in particular, less attractive and more difficult than other school subjects. Efforts made by the GIST project to increase children's enjoyment of science were just as successful with boys as with girls.

In Germany, there is awareness of sex differences in subject choice. For example, 13 percent of girls are reported as taking physics, compared with 87 percent of boys; and 75 percent girls take French, compared with 25 percent of boys. A study of German schoolchildren found that both boys and girls were more interested in technology than in physics, and both sexes preferred practically-oriented programmes. The study concludes that German science education needs innovation not just for girls but also for boys. (Hoffman, 1981). At present, there are no curriculum programmes in Germany to make science and technology more attractive to girls. However, a conference was held in Kiel, in April 1984, to analyse pupils' science interests, with a special session on sex differences. (see References)

The 'Girls, physics and technology in the Netherlands', known as the MENT project is concerned with some of these problems as they affect 12 to 15 year olds in the lower secondary school. In Holland, there are two kinds of secondary school: 60 percent of children receive a general education, 40 percent receive popular vocational training. Within the general education system, there are three types of school: mavo, havo and vwo. Only the last normally leads on to university. In all three, students are taught biology, physics and chemistry in the first three years. The MENT project chose to focus on physics in the second and third year, and developed four main approaches:

- changing content to make it more inviting to girls; e.g. examples using human biology, and stressing aspects of physics in everyday life;
- videotapes were used to study the role of the teachers, and a video of a pendulum experiment reveals some differences between mixed and single sex pairs carrying out work in the laboratory;
- physics textbooks were examined;
- and special emphasis was put on finding the reasons for girls' negative attitudes.

MENT made use of insights from other curriculum development projects, for instance DBK, a team of full time teachers concerned with developing a curriculum for use with mixed ability groups, and NAS, a similar team developing materials round the theme of physics in society.

In Norway, The Girls and Physics Project is located at the Centre for School Science, Oslo University, and is supported by the Norwegian state education authority, the Ministry for Church and Education. It started in 1981, and is described as action-oriented, seeking changes of two kinds:

- a change in the decisions taken by girls;
- a change in the subject, and in classroom practice.

Sjoberg and Lie (1981), describing the Project, have a succinct critique of science education:

'In our opinion the current textbook version of science is a closed and authoritarian activity, where the main point is to reproduce answers to questions you never asked ...part of the ...image of science is ... that of an objective and neutral, "clean" intellectual pursuit isolated from the turmoil of politics, culture, philosophy, production and societal context in general...this image is at odds with all current thinking in epistemology and in the philosophy and history of science..' (p.229).

The project used a network of interested, mostly women science teachers. They also cooperated with a research group who charted the frequency of use of personal pronouns of either sex, and found that in the most commonly used textbooks the male pronoun was used 97 percent of the time. These results came as a surprise to many, as Norwegian textbooks are examined by several consultants, one of whom looks for sex discrimination, to get the necessary official approval. However this study revealed that it is then up to the author or publisher to decide whether or not they will revise their texts accordingly. (Presumably most do so, in order to gain official sales). Two students were also involved in empirical studies, one analysing attitudes, expectations and pupils' factual knowledge, the other involved in a national survey of topics and learning activities in physics.

Results on the physics test (reported in Lie and Bryhni, 1983) show an increasing gap in physics scores between the ages of 11 and 16. They note the 'remarkable fact' that the older girls do not perform better than the younger ones. Part of their work compared girls' and boys' scores on a subtest of spatial ability; the patterns of sex difference on comparisons on the subtest did not support the idea of a 'spatial ability', which might be decisive for the difference in comprehension of physics.

As with other researchers, they found girls' interests characterized by 'a close connection of science to the human being, to society and to ethic and aesthetic aspects'. Interests corresponded with scores on the test. For example, technically interested pupils scored higher on the 'technical' questions. Like GIST, they investigated the different activities and experiences of the two sexes, and found the boys had more 'tinkering' experiences, and the girls more domestic and biological. The results are extremely similar to GIST findings. And, though the test and attitude measures were somewhat different, the general pattern of findings support each other.

Lindholm (1981) reports a pilot study in Sweden to explore how children think and feel about research and science. Carried out by the Council for the Planning and Coordination of Research, which belongs to the Ministry of Education, and has a special delegation for Science Information. Ten and Eleven year-old children were asked to draw a picture and write an essay on the subject: 'Future in the Year 2000'. Their essays and drawings were analyzed for content, and group discussions were taped. Without question, the most important research problems for these children were:

- problems concerning the environment and pollution;

- energy supplies in the future;
- the technological society and its consequences;
- violence and war.

Their attitudes to 'technological progress' were negative, not positive, and interest in space research was not very common. They feared the world would be taken over by computers and robots, and they exhibited feelings of pessimism and powerlessness.

Scientists were themselves fascinated by some of the solutions proposed by the children, for example: 'synthetic ozone to replace the layer which is slowly being destroyed'. (Lindholm, 1981).

Children are more critical and analytical than adults expect. One implication is that the problems children mention would be fruitful ones for treatment in class. No doubt they would require cross-disciplinary thinking, and a move away from the tripartite division of science into physics, chemistry and biology.

The HANDROVER project in Holland (see References to Projects) concerned textbooks and their representation of the role of men and women. Guidelines were produced (a) for avoiding sexist language and sex bias in texts and illustrations, and (b) for curriculum change (see Projects). The guidelines for physics recommend that physics should deal not only with abstract phenomena, but should take examples from daily life and experience as well as industrial practice. The relations between physics and society should be shown by, for example, looking at energy, the environment, transport, arms. Positive aspects should be stressed, while not passing over in silence the negative or threatening aspects. Materials should relate to careers in physics, and should show women in scientific and technical careers. Textbooks should also pay attention to the human body by, for example explaining the concept of energy in the context of the balance of energy in the human body. The history of science, and of women in science, should not be ignored.

A paper from the GIST project (Smail, 1983) on the same topic of changes in the content of school science curricula, advocates not just the removal or modification of masculine examples, but a 'shift from a masculine approach to science, centring round the development of a system of rules... to science with a more feminine outlook, which stresses a concern for people and animals and sees caring for the environment as more important than analysing how far the damage has gone'.

Other initiatives have followed similar lines. In both Holland and the United Kingdom, the science teachers' professional organisation has formed a 'Girls and Physics' subcommittee, to disseminate recommendations to science teachers (Harding, 1983 and Drukker, 1983). A major physics curriculum development project in the Netherlands, PLON, (see references to Projects) is not specifically concerned with girls' underachievement, but, in the context of redesigning the physics curriculum to make it more relevant to children's social interests, the developers are well aware of the need to attract girls by the inclusion of topics such as 'physics in society'

In some countries, crafts subjects (home economics, technical studies etc.) are strictly sex segregated, and regarded as having a strongly sex differentiated vocational base. In others, crafts teaching has been integrated for the two sexes. Even so, when the subjects become optional, boys and girls almost invariably return to the subjects traditionally considered suitable for their sex. In a number of countries, efforts have been made to alter this tendency, for example by making a 'core' of crafts/technology teaching compulsory for all for a longer period.

Some of the analyses and initiatives which have been undertaken are mentioned in B. CURRICULUM OPTIONS, above

D. CRAFTS/TECHNOLOGY

In Austria, partly because of new equality laws, the subjects of handicrafts and needlework have been newly structured for grades 1 to 4 in compulsory schools. In grades 5 to 8, sex-specific training is still included in curricula. Since 1978-9, options have been possible. And since 1980, schools have been allowed to decide whether subjects should be co-educational or single sex. Since the School Organisation Act of 1975, co-education in public institutions has been the norm. (Dorrer, 1981)

The Secretary of State for Women's Affairs has been negotiating improvement in the standard of education of handicraft teachers.

In Flemish-speaking Belgium, state education is fully co-educational, but private education is almost totally segregated. A uniform 'manual expression' curriculum for boys and girls is in preparation. In the first two years of secondary school, four hours of technical subjects, covering 'male' and 'female' crafts, is identical for both sexes (Aelterman, 1981).

In most German Lander, Home Economics (Haushaltslehre) are now part of 'labour sciences' (Arbeitslehre) (Tornieporth, 1981).

Ilja Mottier (1981) notes that, in Holland, girls who leave school at 16 with a four year domestic education' certificate are registered as unskilled workers. Boys at the same age who leave with a 'technical education' certificate are registered as skilled workers.

The British GATE (Girls and Technological Education) project was concerned with girls' experience of technical crafts in all-girls schools as well as in mixed comprehensives. Few girls schools offer more than the traditional domestic crafts for girls. The project has also worked with teachers, and carried out classroom observation (see Section F. below). The report of this project is due to be published very shortly.

The GIST (Girls Into Science and Technology) project was also concerned with technical crafts for girls, but in mixed schools only. In the group of GIST schools, two offered an integrated crafts course for both sexes throughout the first three years of the lower secondary cycle, others for only one or two years. One school still segregated crafts provision, although it is considered that this is possibly illegal under the terms of the British Sex Discrimination Act.

In all the schools, it was rare for more than a few girls to take technical studies when the subject became optional in the fourth year. Girls, their parents and their teachers appeared to agree that these subjects, with their strong vocational focus, would be unsuitable for girls. The attempts of the GIST programme to alter this state of affairs was only partially successful. Both boys and girls in the action schools became much more enthusiastic than a control groups about considering jobs which are non-traditional for their sex. However, actual subject choices differed only slightly from previous years, and from other schools. In the more successful schools, several factors seemed to have operated: a school with a more 'progressive' atmosphere was more likely to take up the issue of sex differences. In schools where more girls chose to do woodwork, metalwork or craft, design technology, the girls had generally experienced some form of positive discrimination, or action to counter their disadvantage. For instance, in one school, girls were taken on a special one-day outing to a design department, in another, to an electronics factory for a one-week work-experience course. Children also met men and women visitors in non-traditional occupations. And in the context of thinking about their choice of subjects for the fourth year, girls appeared to respond better to these visitors, especially the male visitors, than boys. The implication is that boys may find it easier to accept women in men's jobs (though they are less keen about this than girls) than to accept men in women's jobs.

Engineering appears to have an especially 'masculine' image, and, in a number of countries, efforts have been directed at encouraging girls into engineering. For example, at the Institute of Technology in Linköping (Sweden), courses have been arranged for children and parents with interested engineering students as 'teachers', and women engineering students have helped with junior level second year classes. The women worked in pairs in different classes on different themes; for example they got children to build technical models of a harbour, a town, an amusement park, using materials appropriate to the theme. The products were later exhibited for parents and pupils (Granstam, 1983).

The Dutch are preparing a course in basic skills, including technical and domestic skills, to be used throughout the whole range of secondary education, from 12 to 16 years (Mottier, 1983). Also in the Netherlands, the apprenticeship project, mentioned in section B above showed how important it is to have more than one girl in the workplace in order to cope with male sexist attitudes. What does not work is the mere dropping of information, material or courses without explaining the reasons behind them. Even students who do make non-traditional choices may have other reasons than might be supposed for doing so, and it is possible they hardly think about sex roles (Mottier, 1983).

In the United Kingdom, the Engineering Industries Training Board (EITB) has been running a special scheme to recruit and sponsor groups of approximately 50 girls in various regions, starting in the autumn of 1976 with the West Midlands and Surrey. The girls were supported for their first two years of training as technicians, and firms who provided a training place to a girl received an extra grant of £5000. It proved to be important that girls were visited from time to time by someone from the EITB who could help with problems they encountered. A series of interviews with these girls showed up the deficiencies of many schools career programmes (Newton, 1981). Table 2 about here.

Table 2

Reasons given by girls who eventually went into engineering for not taking technical subjects at school.

REASON	Number	%
No facilities	21	44
Girls not allowed, or boys get 'first place'	13	27
Girls officially allowed but strongly discouraged by teachers and/or not allowed to take exams	5	10
Timetable conflicts	5	10
Not socially accepted for girls to do technical subjects	3	6
Parent opposed	1	2

Source: Newton, 1981

E. WORK EXPERIENCE

Brock-Utne mentions a Swedish project, where, in Grade 8, pupils have work experience through visits or short working periods. In 1976-7, an experimental project in several municipalities sent girls to work in traditionally masculine, and boys in traditionally feminine situations. 100 percent of the girls and 93 percent of the boys thought that the practice ought to be followed in years to come. In two of the eleven municipalities, pupils subsequently made non-traditional job choices.

In the United Kingdom, a scheme called 'Futura Girls' brought 24 girls from 12 local schools into one college, where they had a week-long experience of technology, using automated technical equipment and computers, and meeting women engineers and scientists. The week was intended to influence girls who were undecided about opting for technical crafts. Preliminary evaluation suggested that schools had chosen to send technically able girls who were already planning to take technical crafts, rather than 'waverers'. The full evaluation is not yet complete (Brown, 1983).

F. CLASSROOM BEHAVIOUR

In the Netherlands, in Scandinavia and in the United Kingdom particularly, it has been recognised that teachers' attitudes can be of crucial importance in encouraging or discouraging girls from pursuing studies in science and technology. There are few projects which have directly evaluated the effects of teachers' attitudes and expectations. A British national survey of teachers' attitudes to traditional or non-traditional choice of options found that teachers of science, mathematics and technical craft subjects were the most likely to be opposed to giving equal opportunities (Pratt et al., 1984).

A smaller scale study found that science teachers believe boys are more suited to and more able in science than girls, irrespective of actual abilities (Spear, 1983). A Dutch study is examining the way teachers differ in their view

of male or female pupils, by means of sequential quasi-experimental surveys among small groups of teachers, using fictitious pupils (Tesser & Jungbluth, 1983).

Wernersson reports a two-part study of 10 and 13 year olds in Swedish schools. Observation of classroom behaviour showed that boys got more teacher attention.

Sex differences in teacher-pupil interaction appears to be caused by two factors: teachers paying more attention to boys than to girls, and boys making more contact with the teacher. The two factors are probably interdependent. Sweden does not give any attention in teacher-training to sex roles or sex inequality, but the study suggests it would be desirable if they did so. The second part of the study looks at pupils' sex role differentiation. Both age groups distinguished 'masculine' and 'feminine', but activities belonging to the school setting were less sex-labelled. Thirteen year olds gave a more positive value to 'male' activities. This age difference was more marked for girls than for boys. Activities belonging in the school setting (e.g. 'cheating during a test') were not placed as either masculine or feminine. This was interpreted as a sign of the school being comparatively undifferentiated in boys' and girls' experiences of different activities. There is also the implication that school activities may be able to escape sex-typing to some extent, if teachers are willing to avoid endorsing sex stereotypes (Wernersson, 1981).

Verkerk (1981) studied the role of laboratory work in school science, and found no great sex differences in performance on a practical test, as between boys and girls. However, videotaped sessions in which pairs of children carried out instructions for a 'pendulum' experiment found that, in all cases, the measuring of the length of the pendulum was done by a girl, and the pendulum time was mostly measured by a boy. It was always the boy who wrote the results on the blackboard. When two girls were doing the experiment, there was greater cooperation between them than with any other combination (Dumont, 1981).

The British project, Girls and Technical Education (GATE), included classroom observation. It was noticed that the non-disruptive inattention of a group of girls went unchecked in a mixed class, but not in a girls only class. Harding & Randall (1983) writing about the need for more classroom observational studies, say that such research needs to be capable of detecting a range of verbal and non-verbal interactions, and that the knowledge which is generated by such studies should be acceptable as valid by teachers and educational managers. Ethnographic studies cannot, with confidence, produce generalisations; for these quantifiable methods are necessary.

Classroom observation was carried out as part of the GIST project, with the aim, not just of investigating inequalities of interaction, but also helping teachers to develop strategies which could alter patterns of boy-domination. Quantitative evaluation showed that many teachers were able to equalise interactions between girls and boys, at least when an observer was present. Teachers learned to direct more questions specifically to girls, and to become aware of the boys tendency to gain the lion's share of attention. During those parts of the lessons when the quantitative schedule could not be used, observers noted many examples of stereotypical behaviour. The main qualitative finding was that boys 'hog' resources, particularly when they are in short supply.

The effect, in lessons like science and technical crafts, when practical work can be of great importance, is to deprive girls' of experiences which can increase their understanding of scientific and technical processes. Boys in laboratories and workshops displayed a confident assurance of their right to more than a fair share of both teacher's attention and the available resources. A colour video has been made, reconstructing dramatically incidents which were observed by the GIST team; it will be used in inservice training courses for teachers.

G. INTERVENTIONS TO IMPROVE POST-SCHOOL ENTRY OF GIRLS TO SCIENCE AND TECHNOLOGY

In countries where there is a choice of options in the middle of the secondary course, girls are more likely to be siphoned off into 'feminine' subjects such as languages, humanities and the arts. If, however, subject choice is delayed until the school-leaving age, girls have a better chance of staying the course, and may attain as well as or even better than boys. This is the case, for example in Hungary, where girls outnumber boys in the grammar schools, and therefore have a slightly better chance of university entrance, even though it depends partly on a points system, which requires passes in mathematics and physical sciences. However, even in Hungary, there is clear sex-typing of choice at tertiary level (Whyte, 1983).

In Italian secondary schools of the 'Scientific' type, girls were 36.6 percent of the pupils in 1970-71, rising to 45.3 percent in 1977-8. There has also been an increase in the proportion of girls taking science-based courses at university (based on study at the University of Torino, (Viglietta, 1983).

In France, three out of five routes to the Baccalaureat are maths or science-based, (see Table 3). And, although girls are in the minority, they are better represented than in, for example the United Kingdom. There appear to be no initiatives, as yet, in France specifically on girls' entry to applied science, engineering and technology. Instead, there is presently some concern with the increasing 'feminisation' of the arts-based subjects. (OECD, 1983).

Table 3

Type of Baccalaureat and Subject

	1972 <u>% F.</u>	1976 <u>% F.</u>	1981 <u>% F.</u>
A - Philosophy/letters	72.4	76.4	79.6
B - Economic and Social Studies	55.8	62.1	65.0
C - Mathematics and Physical Sciences	32.7	37.0	39.5
D - Mathematics and Natural Sciences	53.7	55.0	57.1
E - Mathematics and Technical Sciences	2.0	3.6	4.0

Source: OECD, 1983

In Norway, new quota systems have been introduced at the tertiary level to encourage the entry of more girls into traditionally male fields (technology, science, medicine) (Tornes, 1981).

Even when it is made somewhat easier for young women to enter science and technology courses, there can be further problems.

In Denmark a recent stagnation in recruitment to engineering led the state organisation for engineering studies to make special efforts to find more women students. The proportion duly rose from just over 7 percent in 1978/9 to nearly 11 percent in 1981/2. However, there was a high female drop-out rate. This appeared to be due partly to the way women were treated: it was frequently assumed, for example, that they were less skilled technically than men: and to their disappointment partly with the content of the course. They had expected engineering studies to give more consideration to social and human problems, such as pollution and scarcity of energy. (Due-Billing and Bruvik-Hanson, 1983).

In Norway, a recent study found that women engineering students preferred 'soft' fields of technology such as biochemistry, biophysics and planning to 'hard' technology, e.g. production, construction (Kvande, 1983). Female students might be seen as a potentially critical force against the dominant values and types of behaviour within the profession, but there are so few women in engineering, that the pressure to adapt to existing professional values may be overwhelming.

A project in the Netherlands was concerned with supporting girls taking technology courses at Eindhoven University of Technology, where about 3 percent of those studying technology were girls. There were also fewer female students at the university as a whole, namely 30 percent. In maths and natural sciences, the proportion was 16 percent and in engineering 4 percent. The idea for action at Eindhoven was stimulated by work at Purdue University, which began 1976. In the Eindhoven scheme, a one-week programme consisted of:

- experience with tools and machines, e.g. in the Department of Physics the girls made an electric doorbells; in Mechanical Engineering, a plummet;
- a woman engineer provided a seminar on technology and society;
- a panel of women engineers, a lecture by a female engineer, and film gave some insight into the position of women in engineering;
- informal contacts between women students were promoted.

The evaluation of this project has now been carried out, although the publication is not yet available. It is entirely possible that girls now come to Eindhoven who would otherwise have gone elsewhere, but chose the university because of its scheme to encourage women. (de Raaff, 1981).

Granstam (1983), in Sweden, has also done a pilot study of women students and graduates in mechanical engineering. The majority thought the so-called girls' courses in technology in the upper secondary school arranged by Granstam and others had been important; only one respondent thought they should not be aimed exclusively at girls. Many were daughters of fathers who had a technical job, often as engineers, though rarely with an academic background. Unexpectedly,

these women did not have particularly high marks in maths and physics. Many mentioned that they had met with prejudiced attitudes. About 20 percent dropped out, usually after the first year of study.

At the university of Turin, Italy, a group of six women have elaborated a project on the teaching of the problem of energy, with the aim of justifying the study of science by means of its applications and its relevance to our everyday lives (Viglietta, 1983) and in the Physics Department at Eindhoven University (Holland) more aspects of technology are to be taught as part of the physics curriculum (Lensink, 1983).

At the University of Loughborough in United Kingdom, courses have run for some time with the goal of attracting more schoolgirls into technology. The project made use of the Newton study (1981) of 345 women engineers and their career development, especially the finding that they had received little encouragement at school. In this project, Loughborough also liaised with the EITB (Engineering Industries Training Scheme). In July 1979, a one-week pilot course was held at Loughborough for seventeen year-old girls who were taking mathematics and science at advanced level. The school liaison scheme included:

- an information package to encourage girls to consider engineering careers;
- women engineers and engineering students were invited to give talks in schools;
- a videotape was developed and shown; and
- visits were organised to local industry (Bullivant and Onions, 1983)

A number of similar courses have started up at other universities around the country, and are now being evaluated with the help of a grant from the Equal Opportunities Commission. Preliminary results indicate that, although the short courses do seem to be enjoyed by girls, and some departments may be increasing the recruitment of women students, problems remain. The content of the actual courses women will take on entry to the universities remains virtually unchanged, and, with their absence of human or social implications, may lead to discouragement and drop out. None of the initiatives mentioned have specifically addressed the possibly stereotyped attitudes and assumptions of the teaching staff, and it may be that residual anti-female prejudice will also contribute to the higher drop-out rate amongst women.

H. OTHER

A number of other schemes and initiatives have been identified, not always specifically aimed at encouraging girls into science and technology, and some are still at rather an early stage of development.

At the University of Aarhus in Denmark, a Girls and Physics working group has been established by staff in the Institute of Physics. So far as is known, they have published no reports of their work; the contact is Dr. Henry Nielsen, University of Aarhus, DK8000 Aarhus C, Denmark.

In France, a special study and report is being prepared on behalf of the Council of European Communities on the impact of information technology on science curricula in secondary schools in France. The author, Claire Terlon,

can be contacted c/o Ministere de l'Education, Institut Nationale de Recherche Pedagogique, 26, rue d'Ulm, 75230 Paris Cedex 05.

The Danish Ministry of Education has set up a Committee on Sex Roles and Education under the Minister of Education, (Ritt Bjerregaard).

In Sweden, a support scheme for women students of science was due to begin in September 1984 at the University of Umea. The contact is Else-maria Staberg, Skolgatan 90, 90246 Umea, Sweden.

The Crew network (Centre for Research on European Women) disseminates regular news and information bulletins to subscribers on initiatives of interest to women in the Member States of the EEC. Most of the information concerns discussions of women's issues and legislation affecting women in the European parliament.

In Italy, there appears to have been no specific investigation of sex differences at school or of 'boys' and girls' approaches to learning in science and technology. However, there is considerable concern about current methods of teaching mathematics and science, and numerous studies of them have been undertaken. There are also great imbalances in teacher training, and in qualification, and the Ministry has commissioned a special report on the situation of women teachers in Italian education. Only 14 percent of heads of schools are female.

An organisation known as Progetto Donna has prepared a guide for teachers of lower secondary school pupils (11-14) entitled 'Masculo-Femino' towards equality of treatment. The work has been supported by the local government of Rome. Chapters make specific suggestions for work with pupils:

- sex role acquisition;
- on teachers, includes tests designed to analyse the self as a role model;
- stereotyping in school organisation discusses disciplinary problems (of increasing concern in Italian urban schools);
- representation of parents on school boards, and how teachers should deal with parents includes exercises for pupils to analyse housework allocated at home;
- curriculum matters includes criteria for choosing non-discriminatory materials/textbooks; sex bias in language and in history; introducing female role models; help for teachers who wish to devise their own teaching materials; setting up teachers' centres at the local level;
- guidance/occupational choice discusses stereotyping in occupational choice.

Further work, if financially supported, will focus on particular aspects of the curriculum, including, especially, mathematics, science and technical education.

In Belgium, a report commissioned by the EEC is currently being prepared, the subject of which will be 'The masculine and feminine stereotypes as presented in education nowadays'. It is to include an exhaustive bibliography of all books,

works, articles, reviews, theses, etc. The contact is Jeanine Evrard, rue de Chambery, 16, B-1040 Bruxelles, Belgique.

Some interesting work is being carried out in Austria, where Ina Wagner has studied women workers in technology, and those working with computers in automated offices, in order to find out more about the facets of technical experience they find most enjoyable. Some of the positive factors she elicited, such as pleasure in perfectionism and fascination with logical structures could well have application to those redesigning science curricula (Wagner, 1984).

In the Netherlands, the Foundation of Curriculum Development is to prepare and publish a survey of ideas, concerning the relation between curriculum development and the preparation of girls and boys for their future social roles, in the hope of gaining access to ideas as they may occur in other Western European countries. The contact is Ria Jaarsma, 1394 BN Nederhorst Den berg, Vreelandseweg 56, Holland.

Conclusions and implications for interventions strategies designed to reduce the underachievement of girls in science and technology.

From the reports of foregoing of intervention strategies employed in various countries, some main implications emerge for strategies which might be used with benefit. Unfortunately, there has been less evaluation of interventions than might be deemed desirable for planning. But there is already sufficient information pointing to the kind of measures which may be recommended. It may be summarized under the same headings used in the main body of this document to describe current endeavours.

A. GENERAL

Studies and reviews of textbooks and of children's literature are a necessary preliminary stage to assessing existing bias in educational materials. Books and resources for science and technology are usually heavily biased towards males, and the production of non-biased materials, incorporating interests and approaches which will appeal to girls, may help towards encouraging them to go into science and technology, though it will not be sufficient as a step on its own.

In several countries, good use has been made of the media - film, television, publishers and journalists - to publicize the 'problem' of equal opportunities. In the United Kingdom, one of the main un-anticipated effects of the GIST programme has been the national publicity it aroused. This has informed parents and the general public, as well as teachers, of the need for remedial action to compensate girls' under-achievement (Kelly et al., 1984).

Activities designed to alter sex-stereotyped attitudes in pupils designed have been mounted in several countries with some success, but it appears to be much easier to change attitudes than to alter such behaviours as choice of subject or of career.

In Portugal and Ireland, the national departments of education have held seminars and meetings for teachers and headteachers to enlighten them about the issues of girls' schooling. A strong element of work on equal opportunities in teacher education, both initial and in-service seems likely to be necessary

if girls are to be encouraged at school. In the Netherlands, and also in certain local education authorities in the London area in United Kingdom, courses have been run to prepare women for management positions in schools. And, in Ireland and in the Netherlands, efforts are being made to recruit more women as teachers of science and technology.

B: Curriculum Options

The most basic need is to collect statistics on girls' and boys' choice of science and technology at every stage of schooling, and to monitor changes in patterns of options. In certain countries, the decision has been taken to broaden the available syllabi for both sexes, and/or to make more subjects, such as technology, compulsory rather than optional. In the Netherlands, policy recommendations included the statement that the freedom of students to choose the examination standard they will take should be removed, as girls tend to under-estimate their own abilities. The Dutch proviso that policies on equal opportunities should be nationally determined, but locally implemented seems sensible and realistic, but it should perhaps be combined with some kind of monitoring and evaluation of progress made.

C: Science

At the most basic level, it is necessary to ensure that girls and boys have at least equal amounts of time for their study of science. In Switzerland, where girls actually receive less science education, it is not surprising if girls are under-achieving relative to boys. A wide range of studies and interventions suggest that the teaching of science itself ought to change in certain specific ways if girls are to be encouraged: the social and human applications of science should feature as part of the science curriculum: textbooks should be revised to incorporate girls' interests and concerns as well as those of boys. In general, a syllabus adapted to include humanistic concerns, and which uses human biology as a 'way in' to more traditional physical science topics will also make the subject more appealing to boys.

D: Crafts/Technology

Ideally, an integrated crafts course should be open to both sexes as part of the compulsory curriculum throughout the full span of secondary education. This involves redesigning the home economics or the traditional 'feminine' element to be of equal interest to boys. For girls, additional efforts are needed to increase their technical competence, for example, by extra training in basic skills.

Engineering in particular has a masculine image, and it will require special measures to encourage the recruitment of girls into engineering. In Norway, a quota system encourages more girls to opt, and in Sweden and in the United Kingdom there have been special schemes which involve bringing women engineers into the classroom. The Dutch apprenticeship project and the Engineering Industries Training Board programmes in the United Kingdom show the need for full support for groups of girls who have chosen engineering or associated apprenticeships or courses after school.

Career counselling at school level tends to be both deficient, often coming after girls have made crucial choices, and stereotyped, directing girls and boys into jobs traditional for their sex. There is a need for

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non-stereotyped careers education. The GIST project, amongst others, suggested that such interventions will meet with some resistance from boys, at least, at first, and more in relation to boys' consideration of occupations formerly considered as feminine.

E: Work Experience

Where work experience placement schemes are in operation, interventions to allow girls and boys to have non-traditional work experience have met with some success.

F: Teachers and Classrooms

Teachers of science and technology are likely to be even more conservative about sex roles than others. Boys are likely to take the leading role in practical work unless special efforts are made to ensure girls' full participation. Girls' inattention is less likely to be noticed by teachers, and boys will tend to 'hog' resources, and teacher time and attention. There is some evidence that teachers can counter the prevailing image of science subjects, and that teachers who are trained by experience of feedback from observers can counter patterns of male domination in the laboratory and classroom.

G: Entry of girls and women to careers in science and technology

Postponement of subject choice is a necessary, but not a sufficient condition for retaining girls in science and technology. Tertiary institutions also have to demonstrate a willingness to accept female students in much greater numbers than before. They can do this by offering special programmes for school leavers, arranging for women engineering students to visit schools, and for schoolgirls to visit workplaces.

Once girls are recruited on to courses, additional interventions are to be recommended: tertiary institutions often fail to include issues and approaches which would interest girls, such as the social implications of technology, dealt with, for example, by a new approach to the teaching of energy, as in the university of Turino. Special support systems are also advisable, such as women student groups, and extended meetings with women already working in engineering.

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